# Classroom Activities

Mapping the Amazon: Clearcutting in the Forest

Subjects

Amazon rainforest, radar imagery, satellite mapping, data processing, scientific visualization, global warming

Background

Deforestation and clearcutting in parts of the world have become almost epidemic. This is the subject of great environmental concern. Habitat destruction threatens to drastically reduce biodiversity worldwide. Of the current species of living organisms, more than 50 percent of all species reside in the tropical rainforests. Estimates reveal that at the current rate of deforestation, more than 100 species are being lost daily worldwide. Some of those organisms might have provided cures for debilitating or fatal diseases.
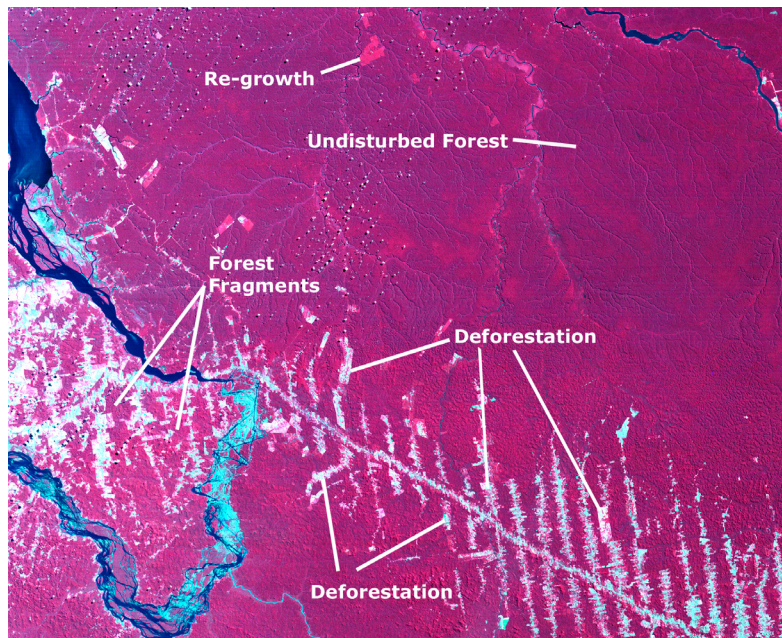
Satellite image of deforestation in the Amazon region, taken from the Brazilian state of Para on July 26, 1996.
The pattern of deforestation spreading along roads is obvious in the lower half of the image.
Source: Tropical Rain Forest Information Center, a member of NASA's Federation for Earth Science Information Partners,
at the Center for Global Change and Earth Observations, Michigan State University (http://www.trfic.msu.edu/trfic/)

Additionally, tropical rainforest deforestation affects worldwide climate. Deforestation reduces Earth's capacity to transform atmospheric carbon dioxide into plant matter via photosynthesis and interferes with the water cycle's evapotranspiration and evaporation ratios. The result is increasing solar energy reaching the Earth's surface and air above it, which causes elevated temperatures. These processes may contribute to global warming.

Tropical rainforest deforestation to provide open land for farming and other development is currently a hot topic among environmentalists, politicians, and private citizens. Topping the list of concerns is the future of the vast "jungles" of the Brazilian Amazon, which grade into savannahs at their edges. Selling land to private farmers or large commercial logging companies is providing capital to countries whose debt is high. Farmers are provided with a means to feed their families. Yet the nutrient-poor soil of the rainforests is depleted within 2 or 3 years, requiring the use of fertilizer and pesticides, which are expensive and run off into water supplies, creating contamination.

It is clear to see that this issue is complicated and has numerous components. Not debated is the reality that we must continue to monitor closely the destruction and rebuilding of the tropical rainforests. This cannot be done effectively from the land or even from aerial views of the land. Satellites are providing new windows on our world from space.

One use of satellite images such as Landsat is to show the clearcutting that has taken place in a specific area and the forest regrowth that is occurring. "Clearcutting" means that all of the trees in an area are cut, not just selected trees. Might there be better alternatives that could result in improved quality of life for the citizens of rainforest countries while protecting valuable natural resources?

Lesson Plan

Objectives:
Students will

Describe the processes and impacts upon humans and the environment of deforestation of the tropical rainforests.
Compare and contrast deforestation techniques including slash and burn, clearcutting, selective deforestation, and shade agriculture.
Use a graph to describe patterns in Brazilian rainforest deforestation from 1975 to the present using NASA satellite data.
Prioritize and defend positions on the importance of global environmental concerns versus individual human need of Brazilian citizens in determining how much of the Amazon rainforest is "cogent" to destroy in order to build farmland and roads.

Engage:

Locate and display pictures of Brazil, its rainforest, and its people (many pictures are available on the Internet). Two are shared from the Tropical Rain Forest Information Center below:

Ground photographs of deforestation in Brazil.
Source: Tropical Rain Forest Information Center, a member of NASA's Federation for Earth
Science Information Partners, at the Center for Global Change and Earth Observations,
Michigan State University (http://www.trfic.msu.edu/trfic/)

Scenario

Consider that you are Miguel Diego, a poor Brazilian farmer. You have a wife and six children. You have purchased Amazon rainforest property and wish to burn off the vegetation in order to create new farmland. You realize that it will soon cost you $300 per hectare to apply necessary fertilizer and pesticides to your nutrient-poor deforested land, but you must quickly create income for your family.

As you prepare to purchase items for your farmland, Mr. Dally, a scientist and environmentalist who works for the Save Our World From People Foundation, confronts you. He reminds you that you are going to be destroying valuable vegetation, which is home to as many as 300 species of trees per hectare, not to mention the millions of species of living plants, animals, microorganisms, future medicinal products, etc., that you will soon thoughtlessly destroy. How can you do this to nature's treasures? You are also contributing to global warming by interfering with the global carbon balance. Did you not know that slash and burn deforestation releases 50 percent of the carbon stored in the tree trunks? Besides, the rain will wash away the few nutrients contained in the soil and your land will be nutrient-starved in just 2 to 3 years. Will you simply buy and burn more land then?

You note angrily that this well-meaning American probably does not have an annual income of only $6,400/person, as is the case in your country (World Bank–1998). Your first priority is to feed your family. Can he tell you a better way to do this in your homeland?

What would you do if you were Mr. Diego? Should it be the right of the people in that country to burn down as much rainforest as necessary to meet human needs? Can you think of any alternative solutions?

Students can work in groups of three to four to discuss the real-world problem. They can use any resources available to discern plausible answers. Two Internet sources are
http://ublib.buffalo.edu/libraries/projects/cases/amazon.html
http://www.bsrsi.msu.edu/rfrc/deforestation.html

Explore:
1. Have students complete the Pre-viewing Activities. Review the vocabulary.
2. Show the video "Journeys through Earth and Space," Mapping the Amazon.
3. Students will complete the Viewing Questions.
4. Discuss answers to the Video Viewing questions.
5. Read the Background on Clearcutting in the Forest.
6. Students will complete:

Activity 1
NASA Investigation. Go to the following NASA site:

Get into the Environment with Landsat
http://edmall.gsfc.nasa.gov/99invest.Site/LANDSAT/land.abstract.html

Read the background and complete Lesson 1.

Activity 2
Using the images of Rondônia, have students compare the satellite images from 1975, 1986, and 1992. They have already answered questions about these in Lesson 1 above. They will now be asked to use mathematical computations to compare the patterns of crosscutting and deforestation during this 17-year span.
Source: http://edcwww.cr.usgs.gov/earthshots/slow/Rondonia/Rondonia

Explain:

Answer discussion questions in Lesson 1 (NASA lesson).

Evaluate:
1. Students defend a debate position citing research, cost/benefit data, environmental predictions, and human benefit/suffering regarding deforestation of the tropical rainforests.

TOPIC: The IO-ME Lumber Company has proposed to purchase 5 square kilometers of Amazon rainforest land in Brazil for the obvious purpose of cutting and selling lumber. The company representatives have met with the Brazilian government officials, who realize that the income from this sale will help lower the sizable national debt and provide programs for the indigent citizens of that company. As a DEBATE TEAM you will assume one of the following roles:

1. The IO-ME Lumber Company team dispatched to make and seal the deal.
2. The Save Our Earth environmental protection group, who notes that if the present rate of rainforest destruction is not halted, then between 2012 and 2016 the virgin rainforests land area will drop below the critical built-in natural safeguard threshold of 10 percent with its 50 percent species remaining. Furthermore, carbon stored in trees will critically alter the greenhouse effect and contribute to global warming. Who really owns this Earth anyway? Is it our right to destroy nature and humankind?

All students will do research to find information relevant to the debate topics. Audience participants will prepare questions to ask each debate team. They will then use a debate team note sheet to take pertinent notes during the debate. A scoring rubric can be developed if the teacher so chooses. Each student will VOTE for the outcome based upon the number of relevant, appropriate notes taken on each column of the debate notes sheet. [Student copy provided at the end of this lesson].

2. Students submit a two-page written essay defending their debate position and listing two specific things they can do to help limit rainforest deforestation.

Extend: Technology
1. Explore Lesson 2 (from NASA Landsat lesson above, and make connections between flooding with El Niño and possible flood effects from rainforest deforestation.
2. Use NIH Image software to calculate percentages of deforestation using Rondônia satellite images in previous lesson.
3. Studying Earth's Environment from Space
http://see.gsfc.nasa.gov/edu/SEES
A Global Land Vegetation Module reviewed by the NASA Earth Science Enterprise Education Product Review Committee is ready for classroom use and can be found on this Web site.
4. Canada Centre for Remote Sensing
http://www.ccrs.nrcan.gc.ca/ccrs/homepg.pl?e
Canada Centre for Remote Sensing Web site lesson: "Watching Over Our Planet From Space. Clearcutting in the Forest." This teacher kit activity can be downloaded cost-free. This activity is an excellent adjunct to the NASA lesson presented in this video guide

segment.

Activity Reading Level: Flesch-Kincaid: 9.0

National Standards (Science Content)
Grades 9-12

Life Science–Content Standard C:
The Interdependence of Organisms
* Organisms both cooperate and compete in ecosystems.
* Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption.

Earth and Space Science–Content Standard D:
The Origin and Evolution of the Earth System
* Interactions among the solid Earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the Earth system.

Science and Technology–Content Standard E:
Understandings about Science and Technology
* Scientists in different disciplines ask different questions, use different methods of investigation, and accept different types of evidence to support their explanations.
* Science often advances with the introduction of new technologies.

Science in Personal and Social Perspectives–Content Standard F:
Environmental Quality
* Natural ecosystems provide an array of basic processes that affect humans.
Natural and Human-Induced Hazards
* Normal adjustments of Earth may be hazardous for humans.
* Human activities can enhance potential for hazards.
* Some hazards . . . are rapid and spectacular. But there are slow and progressive changes that also result in problems for individuals and societies.
* Natural and human-induced hazards present the need for humans to assess potential danger and risk.

History and Nature of Science–Content Standard G:
Nature of Scientific Knowledge
* Scientific explanations must meet certain criteria. First and foremost, they must be consistent with experimental and observational evidence about nature, and must make accurate predictions, when appropriate, about systems being studied.
* Because all scientific ideas depend on experimental and observational confirmation, all scientific knowledge is, in principle, subject to change as new evidence becomes available.

Additional References

The Deforestation of the Amazon: A Case Study in Understanding Ecosystems and Their Value
http://ublib.buffalo.edu/libraries/projects/cases/amazon.html

Rain Forest Report Card: Deforestation of Tropical Rain Forests
http://www.bsrsi.msu.edu/rfrc/deforestation.html

Rainforest Biodiversity: The Scale of Destruction
http://www.rainforests.net/species2.htm

Ancient Forests Video:
http://www.greenpeaceusa.org/forests/

Slash and Burn Agriculture
http://www.cotf.edu/ete/modules/troppois/tpslashburn.html

Tropical Deforestation Fact Sheet
http://earthobservatory.nasa.gov/Library/Deforestation

Science in the Rainforest: Rainforest Facts
http://www.pbs.org/tal/costa_rica/index.html

Rainforest Treat
http://school.discovery.com/lessonplans/programs/habitats/tropicalrainforest/index.html#activities

Teaching Tropical Rainforest Biology
http://www.accessexcellence.org/21st/TL/sly/

"Focusing Radar's Lens: Remote Sensing Tools Reveal Ecological Secrets," INSIGHTS Magazine, January 1998
http://ct.gsfc.nasa.gov/insights/vol4/radar.htm

Credits

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Pre-viewing Activities

Question

Would optical photographs be sufficient pictures of the Amazon for the purpose of studying deforestation of the tropical rainforest? Explain.

Vocabulary to Know

Clearcutting
Flood Plain
Landsat
Mosaic
Remote Sensing
Selective Deforestation
Shade Agriculture
Slash and Burn
Wetlands

Video Viewing Questions

1. The Amazon rainforest is the largest _____ forest in the world.

2. It stretches across _____almost from ocean to _____.

3. NASA began mapping the Amazon from _____.

4. What are two advantages of using satellite pictures to photograph the Amazon area?

5. The Japanese satellite that was used for mapping is called _____. This stands for _____.

6. The satellite collects vast amounts of data. The _____ crunches the data into images of the Amazon.

7. After the images are created they are layered over one another and adjusted to make large _____.

8. These maps are then used to reveal conditions on the ground such as the _____ and the _____ of the Amazon River.

9. The largest city along the Amazon River is _____.

10. Landsat is better at telling what type of _____ is growing and what areas of trees have been cleared.

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Activity 2

Creating and Using a Dot Grid to Measure and Compare Areas of Satellite Images

1. Select a piece of graph paper and lay a piece of acetate (transparency paper) on top of it.
2. Place an ink dot on the acetate at each point where the graph paper lines intersect. Continue across the acetate until you have at least 20 dots across and 20 rows down. The scale of the graph paper is insignificant, as you will be counting units or dots rather than using a specific scale.
3. Print (in color) satellite images showing Rondônia, Brazil, in 1975, 1986, and 1992 from the following Web site:
http://edcwww.cr.usgs.gov/earthshots/slow/Rondonia/Rondonia
Alternatively, one may make color photocopies of the images included in the printed guide or print the pages from the PDF file.
4. Place the acetate dot grid on top of the 1975 satellite image of Rondônia. First, count all dots that lie within the entire satellite image. Be careful to not move the acetate while you are counting. Next, proceed to count the dots that fall within the areas corresponding to the colors in the key for the Landsat image (found on page 34). If a dot is right on the edge of an area, only count it if it is more than one-half inside the area. Otherwise, it belongs to the adjacent area and would be counted twice. From your count, you will need to discern the percentage of dots (out of the total dots) that represent each land feature.
5. Repeat the above dot calculation activity for the 1986 and 1992 images.
6. Using the scale provided on the image, determine the total area that the image represents.
7. Use the conversion factors for metric/English or customary to calculate how many square kilometers of each type of geographical features (pavement, vegetation, etc.) exist.
8. Construct a line graph to depict your findings.

Square Measure:
Square Kilometer = .3861 Square Mile = 100 Hectares = 247.1 Acres
Square Mile = 2.59 Square Kilometers = 259 Hectares = 640 Acres
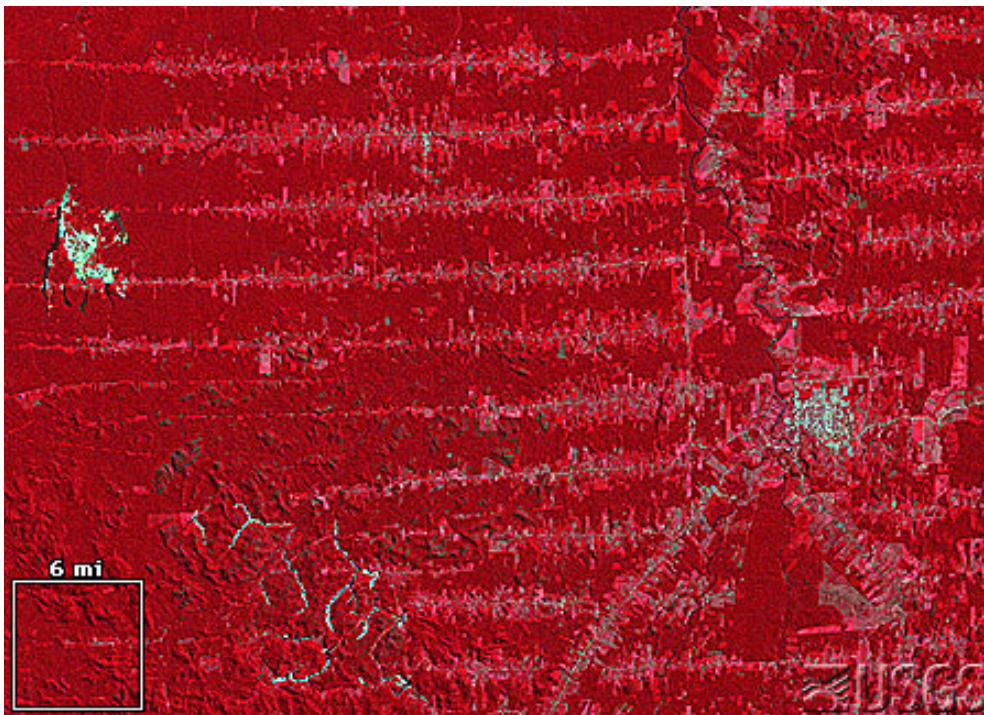
Analysis Questions:
1. Was there a higher rate of percent change between 1975 and 1986 (11 years) or between 1986 and 1992 (6 years)? What about this fact should be alarming to us, if anything?
2. Should the people of Brazil have the right to deforest their part of the Amazon rainforest in order to decrease their national debt and improve the quality of life for their citizens?
3. Should the international community have any rights to limit deforestation within the countries which "own" the natural resources in the world's rainforests?
4. What is YOUR role in protecting the natural resources in the rainforests?
5. List 10 natural resources that will be lost if we continue to destroy rainforests (i.e., specific endangered plants or animals, etc.).
6. How can deforestation in the rainforests affect climate and weather changes worldwide?
7. How have satellites and supercomputers improved our understanding and monitoring of rainforest destruction and its effects?

Satellite Images of Environmental Change
Source: http://edcwww.cr.usgs.gov/earthshots/slow/Rondonia/Rondonia
Rondônia, Brazil 1975
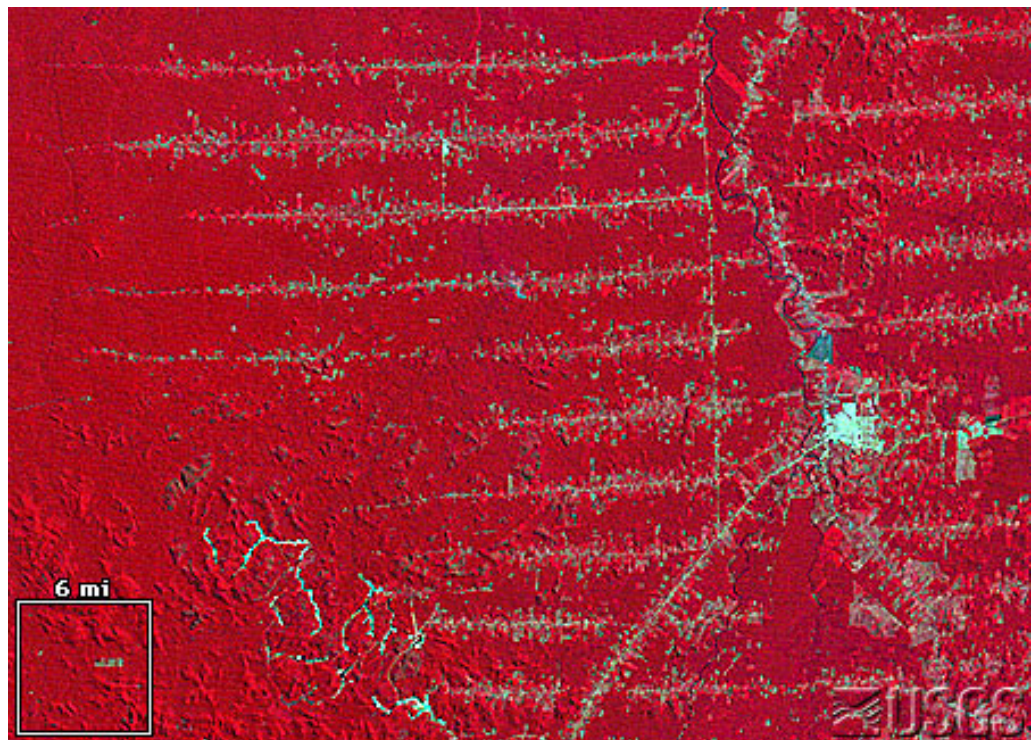
Satellite Images of Environmental Change
Source: http://edcwww.cr.usgs.gov/earthshots/slow/Rondonia/Rondonia
Rondônia, Brazil 1986

Satellite Images of Environmental Change
Source: http://edcwww.cr.usgs.gov/earthshots/slow/Rondonia/Rondonia
Rondônia, Brazil 1992

KEY
◊ Red = Vegetation
◊ Pink = Grazing Land
◊ Green-yellow = Cropland
◊ Light blue or blue-green = Pavement or bare soil
◊ Dark blue or black = Bodies of water

Rainforest Deforestation Debate Notes Worksheet

IO-ME Lumber Purchasing Team	Save Our Earth Environmental Protection Team
TOTAL=	TOTAL=

Write abbreviated cogent and appropriate points made by each team/one per row. At the end you will tally points made for each team.

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Educators' Answer Key

Pre-viewing Activities

Question

As the students have not watched the video yet, it may be useful to prime them by mentioning how big the Amazon rainforest is, which will get them thinking about how difficult it is to photograph an immense area.

Video Viewing Questions

1. Tropical
2. South America, ocean
3. Space
4. The satellite described in the video can cover the Amazon rain forest in 2 months and penetrate clouds and smoke.
5. SAR, synthetic aperture radar
6. Supercomputer
7. Mosaics
8. Tree-clearing that happened between the low water and high water seasons, changing course
9. Manaus
10. Vegetation